ary since the last of July. While the river at Red Bluff averaged slightly above the low water of 1908, it was, with this exception, the lowest ever recorded during any month. Below Red Bluff, especially in most of the reaches between Colusa and Knights Landing, there was little interruption in the fall of the river during the month.

At Colusa the Sacramento averaged 1.1 foot, which is 1.4 foot below the August normal stage, and 1.2 foot below the low water of 1908.

At Knights Landing the zero stage was reached on the 9th of the month, and on the 31st a stage of 0.3 below zero was recorded, which is the lowest stage ever before noted at this point.

At Sacramento the river averaged 0.1 foot above the previous lowest monthly average, which was in September, 1908, and 2.4 feet below the August normal stage. At this point the fall was frequently interrupted by the tides, which, in some cases, amounted to a rise of as much as 0.4 foot. Below Sacramento there was little departure from the summer stage, except that the effects of flood tides were more marked than usual.

In some of the reaches the Sacramento has left its usual summer channel, and, as a result, navigation has been rendered difficult, and frequent groundings have occurred among the large craft.

The Yuba River at Marysville averaged over 1 foot below the usual August stage, and was 0.8 foot lower than the previous lowest average for the month. The run-off in the numerous forks of this stream was markedly deficient, so much so that it is reported that several mines have been compelled to close on account of the scarcity of water.

At Oroville the Feather averaged 1.4 foot below the usual August stage, and nearly 1 foot below the lowest previous monthly average of which there is a record. At the close of the month all the feeders of the Feather River carried less water than they have ever been known to carry before.

The American River at Folsom averaged 0.6 foot below the normal August stage, and was 0.3 foot lower than the low water of August, 1908. The run-off of all streams in the headwaters of this river diminished very slowly during the month, and the American itself exhibited an unusually sluggish condition, there being a range of only 0.1 foot between the highest and lowest stages.

San Joaquin watershed.—All reports received from streams in the drainage basin of the San Joaquin during August show a steady but gradual decrease in the water supply, and, in some cases, exhibit lower gage readings than have ever before been recorded. The Stanislaus at Melones averaged over 3 feet below the zero of the gage. The Mokelumne at Electra averaged 0.1 below zero, and the Tuolumne at Jacksonville averaged 0.3 foot above the zero of the gage. The Merced River at Merced Falls averaged 0.8 foot below the zero of the gage and 0.4 below the lowest previous average for the month of August.

The San Joaquin River itself was markedly below its usual August stage from Pollasky to Lathrop, but from Lathrop to the lower islands there was little departure from the normal summer stage.

SMOKE FROM BURNING FORESTS.

The British ship *Dunfermline*, which arrived at San Francisco from Newcastle, Australia, August 31, 1910, reports that the smell of the forest fires was noticed when the ship was 500 miles from land. The odor of burning wood was quite unmistakable and officers of the ship stated that they expected to find evidence of a great conflagration upon reaching port. The haze from the forest fires made it impossible to get an observation for about 10 days.

The observation is of unusual interest because the prevailing winds in this region are from the west or northwest. During the morning hours, however, there is a gentle movement of the lower air from the land seaward. It seems hard to realize that the smoke should have been carried so far from the land.

MOUNTAIN SITES FOR OBSERVATORIES ON THE PACIFIC SLOPE.

By A. G. McADIE.

It was the writer's privilege to be a member of Doctor Campbell's expedition to the summit of Mount Whitney in August, 1909, when certain spectroscopic studies were made of the atmosphere of Mars. The site was selected, after some preliminary investigations by Messrs. Campbell and Abbot, because it is practically above the level of the water vapor of the atmosphere. This virtually eliminates absorptive effects due to dust, haze, water vapor, and other matter prevailing in general in the lower air strata. The elevation is 4,400 meters and the general climatic reputation one of clear weather and extreme dryness. Mount Whitney is historically familiar because of Langley's early work on the transparency of the atmosphere and his determination of the value of the solar constant. Langley's work was carried on not at the summit, but some 600 meters below, over on the Kern side, at what is now known as Langley's Camp. In 1909 Abbot repeated to some degree the earlier observations, using, however, the summit. His is the first use of a complete bolometric outfit at an elevation above 4 kilometers.

The station has again been occupied during the present season by Abbot and doubtless some valuable solar energy curves were obtained for comparison with those made at lower levels.

Acting on the recommendation of Messrs. Campbell and Abbot, Dr. C. D. Walcott, Secretary of the Smithsonian Institution, authorized the construction of a small stone building on the summit, and this shelter is now available for astrophysical purposes. The erection of this shelter is in line with the development of high-level observatories in America. The establishment of the Lick Observatory may be said to mark the beginning of the movement in favor of sites where research could be conducted under atmospheric conditions markedly different from those where the great astronomical observatories of the world were situated, namely, at low levels and near centers of population. Harvard Observatory early recognized the value of high-level sites and established observing stations in South America. The inauguration of the Solar Physics Observatory at Mount Wilson is but a progressive development and clearer recognition of the necessity of carrying on work where there is the greatest possible freedom from the atmospheric disturbances so common at low levels.

Primarily the degree of definition or clearness of seeing will determine the reputation of both observatory and observer. The astrophysicist is handicapped by his inability to get away from earth; or to get out of the convectional region, i. e., from the surface up to the region of constant temperature. If it were possible to work at an elevation of about 11 kilometers, it would be found that the "load," as it may be called, of foreign matter in the atmosphere is practically *nil*, and that the several gases are distributed according to their molecular weights. The so-called isothermal region is one in which there is no vertical convection; and also, because of the absence of water vapor, one where absorption of solar radiation is a minimum. Professor Turner has pointed out that such conditions must materially affect refraction.

Recent discussion of the amount of water vapor in the atmosphere of Mars shows the need of some better knowledge of the amount of water vapor in the lower air strata. Water vapor is present to the extent of 1.2 per cent of the total gases at the surface of the earth (according to Humphreys[1]), and decreases rapidly with increase of elevation to an imperceptible amount at or below 10 kilometers. It is plain, therefore, that for problems connected with planetary atmospheres, as well as solar and stellar atmospheres, and for work bearing upon solar radiation, the greater the altitude, other things being equal, the more accurate the work. If one stops to consider the irregular dis-

[1] Mount Weather Bulletin, Vol. 2, Part 2, p. 66.

tribution of heat near the ground, the marvel is not that definition is sometimes poor, but that the wave front is not more distorted and to such a degree as to prevent anything like good definition. This is especially true during the day hours and for some time after sunset. The convectional currents resulting from differences in temperature due to radiation, and, in a small degree, conduction of heat near the surface undoubtedly affect seeing. The best seeing, as a rule, occurs during the early morning hours. Doubtless a curve could be developed showing a close relation between seeing and instability of the lower air. This is a matter of importance in solar work when conducted on mountain sites; and, especially if, as in the case of Mount Whitney and other peaks in the high Sierra, there are steep walls or precipitous sides favoring the development of strong afternoon ascensional currents.

Hale, in discussing the conditions on Mount Wilson, shows that the seeing is best during the early morning hours, although frequently good in the late afternoon:

Shortly after sunrise the sun's limb is serrated, but this effect becomes less and less marked as the sun's altitude increases. Usually at this time in the morning the atmosphere is almost perfectly calm and cloudless. The seeing usually improves and reaches a maximum, where it remains for some time. The effect of the heating of the mountain then becomes apparent and the definition deterioriates. Disturbances at the sun's limb under these conditions do not resemble those seen immediately after sunrise, but have a fluttering appearance, which we are accustomed to speak of as the heating effect. In the late afternoon the seeing usually improves, but is rarely very good at midday. This is not a rule without exception, however, as we have sometimes recorded nearly perfect definition during the hottest hours of the day.[2]

The particular class of disturbances here referred to is probably caused by ground heating effects. The instability of the air may be effective up to a height of 100 meters. There is another class, which will be referred to later, where the instability of the air occurs at a much higher level and is not directly caused by earth heat. Poor definition, caused by the first of the above-named conditions, can, to some degree, be counteracted by mounting the telescope at an elevation of 20 or more meters above the ground. Hale has shown that at a height of 25 meters there is a marked improvement in definition. He has also demonstrated beyond criticism the value of modern construction and design in the prevention of irregular heating of the air column.

Finally, in selecting a mountain site for an observatory, one must consider the effect of storm frequency. In this respect the mountains of California, south of the Tehachipi, have a marked advantage over mountains in other sections of the country. Few storms pass that way. This means that there is less stratification of the air and in general better definition, provided the telescope is mounted at some height. With the passage of each cyclone and anticyclone, ascensional and descensional circulations are established and not infrequently marked temperature inversions occur. There may be an inversion of temperature close to the ground, and, at the same time, another inversion at a considerable elevation. One may be due to cold, slow-moving air currents near the earth's surface; while another may be due to the approach of the warm center of an area of high pressure. Recent investigations of the free air have brought to light the fact that up to a level of about 3 kilometers regular temperature gradients or gradients approximating the adiabatic rate of cooling are the exception rather than the rule. We have an almost incessant warming of air due to compression of descending masses on the one hand and a cooling of air due to expansion in rising, and the whole materially modified, especially in the lower level by the water vapor present.

The highest efficiency, therefore, is to be obtained by the establishment of observatories in regions where there is a minimum, both of storm action and of vertical circulation, where inversions of temperature are infrequent and where there is a minimum amount of water vapor.

[2] Study of Conditions for Solar Research at Mount Wilson. Yearbook No. 3, Carnegie Institution, page 170.

MEETING OF THE SOLAR RESEARCH UNION AT MOUNT WILSON, CAL.

The International Union for Cooperation in Solar Research held its Fourth Conference at the Mount Wilson Solar Observatory, California, August 29 to September 3, 1910. Previous meetings of the Association were held at St. Louis, Oxford, and Paris. The next meeting will be held at Bonn in 1913. The following members of the Fourth Conference were present at Mount Wilson:

Prof. J. S. Ames,	Johns Hopkins University,	Baltimore, Md.
Prof. Charles G. Abbot,	Smithsonian Astrophisical Observatory,	Washington, D. C.
Prof. Walter S. Adams,	Mount Wilson Solar Observatory,	Mount Wilson, Cal.
Prof. Harold D. Babcock,	Solar Observatory,	Mount Wilson, Cal.
Prof. J. O. Backlund,	Observatoire de Poulkovo,	Poulkovo, Russia.
Prof. E. E. Barnard,	Yerkes Observatory,	Williams Bay, Wis.
Prof. A. Belopolsky,	Observatoire de Poulkovo,	Poulkovo, Russia.
Prof. Jean Bosler,	Observatoire de Meudon,	Meudon, France.
Prof. F. P. Brackett,	Pomona College,	Claremont, Cal.
Miss Cora G. Burwell,	Solar Observatory,	Mount Wilson, Cal.
Prof. W. W. Campbell,	Lick Observatory,	Mount Hamilton, Cal.
Prof. C. A. Chant,	University of Toronto,	Toronto, Canada.
Prof. Henri Chretien,	Observatoire de Nice,	Nice, France.
Rev. P. R. Cirera, S. J.,	Observatorio del Ebro,	Tortosa, Spain.
Dr. W. W. Coblentz,	Bureau of Standards,	Washington, D. C.
Rev. A. L. Cortie, S. J.,	Stonyhurst College Observatory,	Lancashire, England.
Prof. A. Cotton,	Ecole Normale Superieure,	Paris, France.
Prof. H. Deslandres,	Observatoire de Meudon,	Meudon, France.
Prof. N. Donitch,	Observatoire de l'Universite,	St. Ptersburg, Russia.
Prof. Frank L. Drew,	Solar Obsevatory,	Mount Wilson, Cal.
Prof. F. W. Dyson,	Royal Observatory,	Edinburgh, Scotland.
Prof. Ferdinand Ellerman,	Solar Observatory,	Mount Wilson, Cal.
Dr. P. Eversheim,	University of Bonn,	Bonn, Germany.
Prof. Chas. Fabry,	University de Marseilles,	Marseilles, France.
Dr. Edward A. Fath,	Solar Observatory,	Mount Wilson, Cal.
Mrs. W. P. Fleming,	Harvard College Observatory,	Cambridge, Mass.
Prof. F. E. Fowle,	Smithsonian Astrophysical Observatory,	Washington, D. C.
Prof. A. Fowler,	Imperial College of Science and Technology,	South Kensington, London, England.
Prof. Philip Fox,	Dearborn Observatory,	Evanston, Ill.
Prof. E. B. Frost,	Yerkes Observatory,	Williams Bay, Wis.
Dr. Henry G. Gale,	University of Chicago,	Chicago, Ill.
Prof. L. H. Gilmore,	Throop Polytechnic Institute,	Pasadena, Cal.
Miss C. D. Griffin,	Solar Observatory,	Mount Wilson, Cal.
Prof. George E. Hale,	Solar Observatory,	Mount Wilson, Cal.
Prof. M. Hamy,	Observatoire de Paris,	Paris, France.
Prof. J. Hartmann,	Koenigliche Sternwarte,	Goettingen, Germany.
Prof. K. Haussmann,	Technische Hochschule,	Aachen, Germany.
Prof. J. V. Hepperger,	Imperial Observatory,	Vienna, Austria.
Major E. H. Hills,	32 Prince's Garden,	London, England.
Prof. W. J. Humphreys,	U. S. Weather Bureau,	Washington, D. C.
Professor Idrac,	Observatoire de Muedon,	Meudon, France.
Prof. J. C. Kapteyn,	Astronomical Laboratory,	Groningen, Holland.
Prof. H. Kayser,	University of Bonn,	Bonn, Germany.
Dr. Arthur S. King,	Solar Observatory,	Mount Wilson, Cal.
Prof. H. Konen,	Physikalisches Institute,	Muenster, Germany.
Prof. F. Kuestner,	Koenigliche Sternwarte,	Bonn, Germany.
Prof. C. O. Lampland,	Lowell Observatory,	Flagstaff, Ariz.
Sir Joseph Larmor,	Royal Society,	London, England.
Miss Jennie B. Lasby,	Solar Observatory,	Mount Wilson, Cal.
Prof. A. O. Leuschner,	University of California,	Berkeley, Cal.
Prof. H. C. Lord,	Emerson McMillin Observatory,	Columbus, Ohio.
Prof. A. G. McAdie,	U. S. Weather Bureau,	San Francisco, Cal.
Dr. Walter M. Mitchell,	Detroit Observatory,	Ann Arbor, Mich.
Prof. H. F. Newall,	University Observatory,	Cambridge, England.
Prof. F. G. Pease,	Solar Observatory,	Mount Wilson, Cal.
Prof. E. C. Pickering,	Harvard College Observatory,	Cambridge, Mass.
J. S. Plaskett, Esq.,	Dominion Observatory,	Ottawa, Canada.
Comte A. de la Baume Pluvinel,	7 Rue de la Baume,	Paris, France.
Prof. E. Pringsheim,	University of Breslau,	Breslau, Germany.
Prof. P. Puiseux,	Observatoire de Paris,	Paris, France.
Prof. A. Ricco,	Osservatorio Astrofisico,	Catania, Sicily.
Prof. W. G. Ritchey,	Solar Observatory,	Mount Wilson, Cal.
Rev. J. S. Ricard, S. J.,	Santa Clara, College,	Santa Clara, Cal.
Prof. A. L. Rotch,	Blue Hill Observatory,	Hyde Park, Mass.
Dr. Herny Norris Russell,	Princeton University,	Princeton, N. J.
Prof. J. R. Rydberg,	University of Lund,	Lund, Sweden.
Dr. Charles E. St. John,	Solar Observatory,	Mount Wilson, Cal.
Prof. Fernando Sanford,	Stanford University,	Palo Alto, Cal.
Dr. Frank Schlesinger,	Allegheny Observatory,	Allegheny, Pa.
Prof. Arthur Schuster,	Victoria Park,	Manchester, England.
Prof. K. Schwarzschild,	Astrophysikalisches Observatorium,	Potsdam, Germany.
Prof. F. H. Seares,	Solar Observatory,	Mount Wilson, Cal.
Dr. V. M. Slipher,	Lowell Observatory,	Flagstaff, Ariz.
Prof. Frederick Slocum,	Yerkes Observatory,	Williams Bay, Wis.
Miss Ruth E. Smith,	Solar Observatory,	Mount Wilson, Cal.
Prof. S. W. Stratton,	Bureau of Standards,	Washington, D. C.
Prof. K. Struve,	Koenigliche Sternwarte,	Berlin, Germany.
Prof. S. D. Townley,	Stanford University,	Palo Alto, Cal.
Prof. H. H. Turner,	University Observatory,	Oxford, England.
Miss Louise Ware,	Solar Observatory,	Mount Wilson, Cal.
Miss Phoebe Waterman,	Solar Observatory,	Mount Wilson, Cal.
Prof. F. R. Watson,	University of Illinois,	Champaign, Ill.
Prof. H. C. Wilson,	Goodsell Observatory,	Northfield, Minn.
Prof. A. Wolfer,	Sternwarte des Eidgenossischen Polytechnikums,	Zurich, Switzerland.

The Mount Wilson Solar Observatory was established as a Department of the Carnegie Institution of Washington in 1904. There is now in operation a 60-inch reflecting telescope with a primary focus of 25 feet and mirror combinations, giving equivalent foci of 80, 100, and 150 feet. Used with this telescope are various stellar spectrographs. The Snow horizontal telescope has a mirror of 24 inches aperture and a focal length of 60 feet

This telescope is used with an 18-foot solar spectrograph. There is also a 5-foot spectroheliograph for direct photography of the sun. The tower telescope has an objective of 12 inches aperture and 60 feet focal length. A 30-foot solar spectrograph, also a 30-foot spectroheliograph are used in the study of sun-spot spectra, the investigation of solar rotation, and the spectra of the chromosphere and center and limb. A second tower telescope has an objective of 12 inches aperture and 150 feet focal length, giving a solar image 17 inches in diameter. In order to get a wider range of dispersion new instruments are in course of construction.

The machine shop, instrument, and optical shops and the physical laboratory are located in Pasadena. These are well equipped. The new 100-inch mirror will be figured and ground in the shops. A list of the investigations in progress or recently completed at Mount Wilson includes the following:

Daily direct photographs of the sun, spectroheliograms in calcium and hydrogen light, and special spectroheliograms with high dispersion, for the general investigation and classification of the flocculi and prominences, including structure at different levels, effect of absorption, possible influence of anomalous refraction, and relationship to sun-spots.—Messrs. Hale and Ellerman.

Law of solar rotation as determined by the motions of the hydrogen and calcium flocculi.—Messrs. Hale and Ellerman.

Daily areas of calcium flocculi, and comparison with records of terrestrial magnetism.—Messrs. Hale and Ellerman, in cooperation with Dr. Baker.

A general investigation of solar magnetism, including determinations of polarity and field strength for various elements and at different levels within and outside of sun-spots, inclination of axis of the electric vortex, rotation of plane of polarization by spot vapors, relationship of polarity to structure of hydrogen and calcium flocculi.—Messrs. Hale, Ellerman, and Babcock.

A general investigation of sun-spot spectra, including wave-lengths and origin of spot lines, cause of weakened and strengthened lines, etc.—Messrs. Hale and Adams.

Photographic investigation of the spectrum of the chromosphere, including wave-lengths and origin of bright lines, cause of displacements, etc.—Messrs. Hale and Adams.

Absolute wave-lengths of the H and K lines.—Mr. St. John.

General circulation of the solar calcium vapor as indicated by the displacements of the H and K lines.—Mr. St. John.

Spectroscopic study of the motions of vapors in sun spots.—Mr. St. John.

Spectroscopic investigation of the rotation of the sun as determined by the displacements of lines of different elements.—Mr. Adams.

Comparison of the spectra of the center and limb of the sun.—Mr. Adams.

Direct photography:
- Of nebulæ and star clusters.—Mr. Ritchey.
- Of the Kapteyn Selected Areas.—Mr. Fath.
- Investigations in photographic photometry.—Mr. Seares.

Spectroscopic investigations:
- Of nebulæ and star clusters.—Mr. Fath.
- Of bright stars under very high dispersion.—Messrs. Hale, Adams, and Babcock.
- Radical velocity investigations of faint stars with low dispersion, including parallax stars and Orion type stars.—Messrs. Adams and Babcock.

Electric furnace investigations of the effect of varying temperature on spectra.—Mr. King.

General work on arc and spark spectra under a great variety of physical conditions.—Mr. King.

Complete study of the Zeeman effect through a large range of wave-lengths for various spectra, and tests for polarization, etc., for special spectrum lines.—Messrs. King and Babcock.

Study of the effects of pressure on spark spectra, with special reference to enhanced lines.—Mr. Gale.

On the absorption of light in space.—Mr. Kapteyn.

Statistical investigations relating to stellar evolution.—Mr. Kapteyn.

Study of special groups of star streams.—Mr. Kapteyn.

The meeting decided by unanimous vote to enlarge the scope of the work carried on by the Solar Union, to include research in astrophysics as well as solar physics.

It was also unanimously agreed to adopt a standard scale of wave-lengths, to be known as the International and the unit used to be known as the International Ångström. Reports were received from various committees on various questions on solar rotation. Committees were appointed on standard wave-lengths, measurement of solar radiation, spectroheliographic investigation of the spectra of sun-spots, eclipse observations, and determination of solar radiation.

The accompanying illustrations are reproduced through the courtesy of the Sierra Club.

Fig. 1.—Looking northwest from Mount Whitney. (From photograph by Dr. W. W. Campbell.)

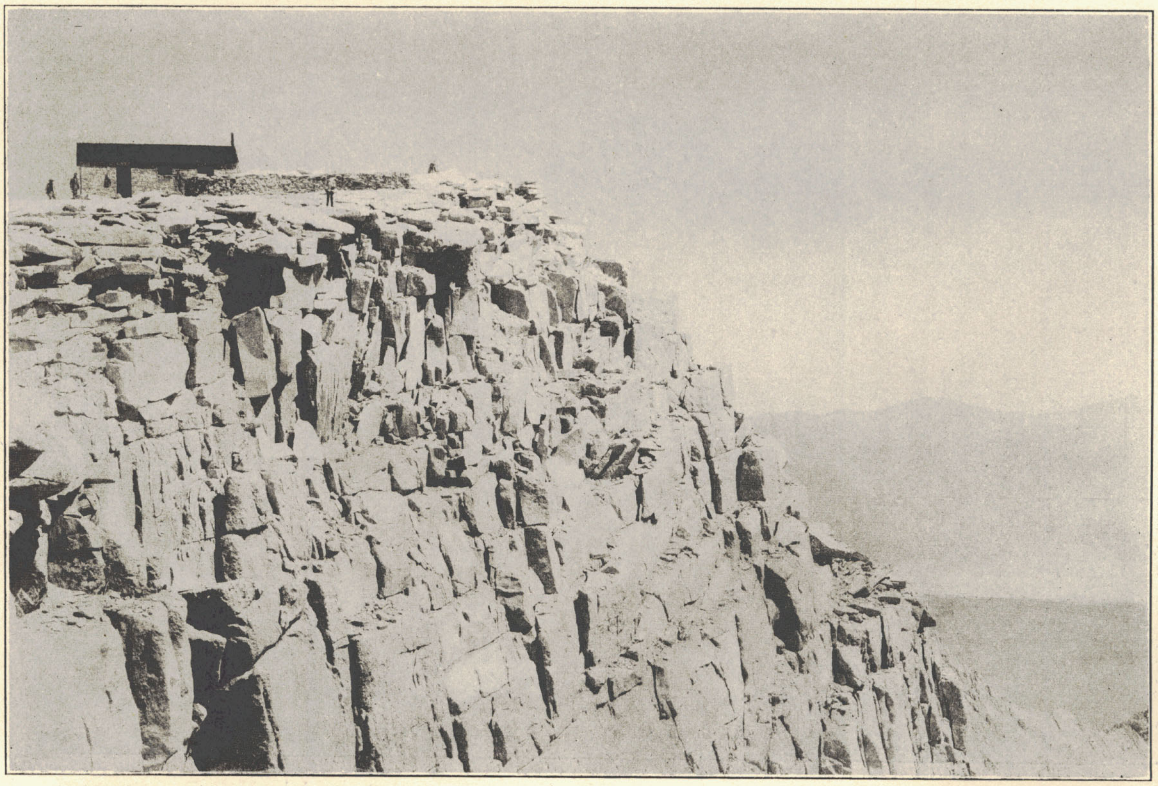

Fig. 2.—The Observatory on Mount Whitney, 14,502 feet. (From photograph by Dr. W. W. Campbell, 1909.)

FIG. 3.—Abbot's Spectrobolometer for determining solar constant. The summit of Mount Whitney, 14,502 feet. (From photograph by Dr. W. W. Campbell.)

FIG. 4.—Eastern face of Mount Whitney from Lone Pine Trail. (From photograph by U. S. Department of Agriculture.) Face of cliff, 2,000 to 3,000 feet shear.